Coastal Engineering Technical Note

AIRBORNE COASTAL CURRENT EVALUATION SURVEY SYSTEM

<u>PURPOSE:</u> This Technical Note introduces a new method for collecting current measurements at multiple locations in a localized region over a short period of time. This new method can provide qualitative spatial resolution of bottom current patterns and can be operated near structures, in high energy regimes, and in shallow or quickly changing bathymetry.

<u>BACKGROUND:</u> In order to better understand coastal processes and evaluate or predict the effect of placing a structure in the nearshore, current patterns need to be examined. Dye studies are valuable in delineating only surface or near-surface currents. Prior to development of the Airborne Coastal Current Evaluation Survey System (ACCESS), spatial resolution of bottom current patterns required placement of an entire suite of instruments to blanket an area and collect data simultaneously. Often this stationary bottom current acquisition technique was ruled out because of the enormous expense associated with placement and maintenance of the large array of meters. Another option is to use several boats and instruments to collect this data, but boats are often limited by bathymetry, wave and current conditions, or inability to navigate about structures. The ACCESS technique may be applicable to many situations where these limitations have previously prevented collection of current information.

Initial deployments of ACCESS used an S-4 InterOcean Inc. electromagnetic current meter, suspended by cable from a helicopter to measure currents at several locations within a short period of time to create a qualitative mosaic of local current patterns. This technique was developed at the Coastal Engineering Research Center (CERC) as part of the Monitoring of Completed Coastal Projects (MCCP) research program's Siuslaw River, Oregon project. The helicopter was selected as the work platform because of its ability to quickly transit between measurement sites and to operate in high energy, nearshore zones and around structures. The S-4 current meter was selected because an electromagnetic current meter has no moving part to foul, its compact size, and its built-in ability to measure depth and direction. The S4 can store data internally or transmit signals to a remote computer. Additional sensors provide salinity and temperature.

<u>EQUIPMENT:</u> The helicopter for ACCESS applications must be large and powerful enough to accommodate a pilot and a co-pilot, a winch person, and the current meter string and anchor weight. If remote real-time display of data is required, a computer and operator must also be accommodated. The helicopter must have a side-mounted power winch with sufficient power and lift capability to raise and lower the meter and its anchor weight. Fuel capacity of the aircraft and the pay load weight will establish the time limit between refueling. The number of sampling sites can also vary greatly depending upon distance to the study location and the distance between sampling sites.

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The S-4 electromagnetic current meter is a multi-parameter meter capable of measuring both depth and current velocity. It has an on-board magnetic compass and tilt sensors used to compensate for gage orientation. It is capable of recording data internally as well as passing it to an external computer. The current meter is connected to an anchor made up of 4 lead balls weighing 200 lbs in total and moored to the lower eye of the instrument approximately one meter below the instrument housing. A sub-surface buoy providing 30 lbs of lift is rigged approximately one meter above the instrument to keep it suspended and vertical in the water column. The four lead balls together create a foot print not easily rolled or moved on the seabed, once disassemble can be easily handle by a single person. The one-meter between components distance minimizes interference with the S4 meter operation. More weight and buoyancy may be necessary in swifter currents. A copper wire weighted with a 5 lb bag weight is attached to the bottom of the current meter string to dissipate static charge developed by the helicopter. The meter assembly is shackled to the helicopter's rescue winch for raising and lowering to the sea floor.

A separate electrical umbilical married with a 3/8 inch support line connects the instrument through an RS232 interface to an on-board Zenith laptop computer powered by a 12 volt battery. This line is not intended to support the weight of the instrument string, and is tended by hand as the instrument is lifted in and out of the water. Figure 1 shows the S-4 meter string and computer assembly. Figure 2 illustrates the meter assembly as it would appear attached to the helicopter and in use at the sea floor.

Data is collected and stored internally within the S-4 and externally in the computer. The computer is used for two reasons. First, it provides a backup data record in case the instrument becomes fouled and has to be released. Second, the effects of static electricity generated by the helicopter are unpredictable and the data stream can be monitored to insure that the instrument is providing quality data.

In the event that the equipment must be released, all lines to the helicopter and computer are equipped with quick releases. Great care should be taken to coil the electrical line in a fashion so that it can be jettisoned as a unit without endangering the aircraft, crew, or mission. A surface buoy attached to the end of the electrical umbilical support line is included to aid in relocation and recovery of the current meter string.

During data collection, horizontal positioning of the helicopter is accomplished in two ways. Line of sight positioning by the pilot to range markers on the beach, jetties, or both is used for approximate positioning and to speed up the maneuvering process. Accurate position coordinates are achieved by sighting prisms mounted on the helicopter with a Total Electronic Positioning Station located onshore.

METHOD: During operation, the helicopter pilot aligns the aircraft with the range poles. Distance from the poles is radioed to the pilot by the survey crew on land using the Total Station. Once in position the current meter string is lowered until the weights rest on the sea floor and the exact location of the helicopter is recorded. The helicopter must hover directly over the meter while current vector information and instrument depth is recorded at a two-Hertz frequency. Sampling times vary with site and study objective: one minute is typical. A second position measurement is taken by the survey crew at the end of the interval. After the second position is recorded the helicopter lifts the meter string from the water and moves along a line of sight to the next

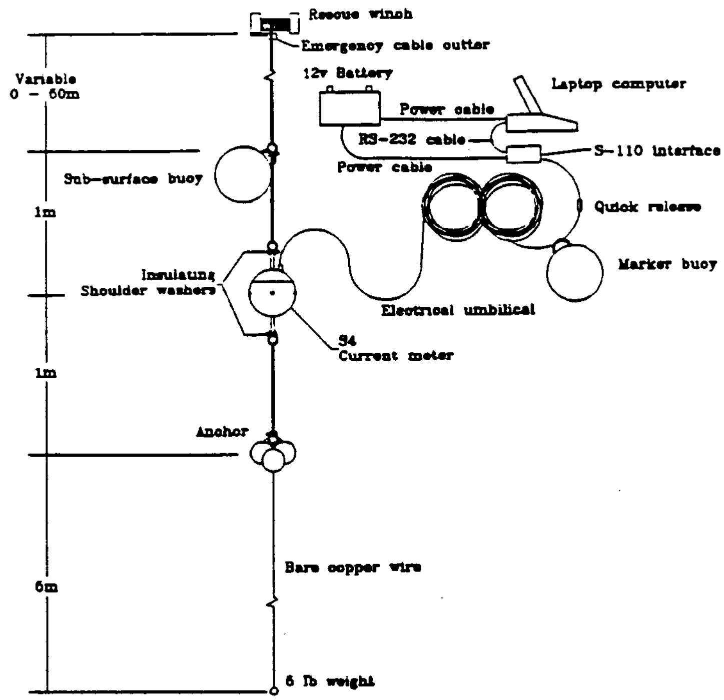

Figure 1. S-4 meter string and computer assembly

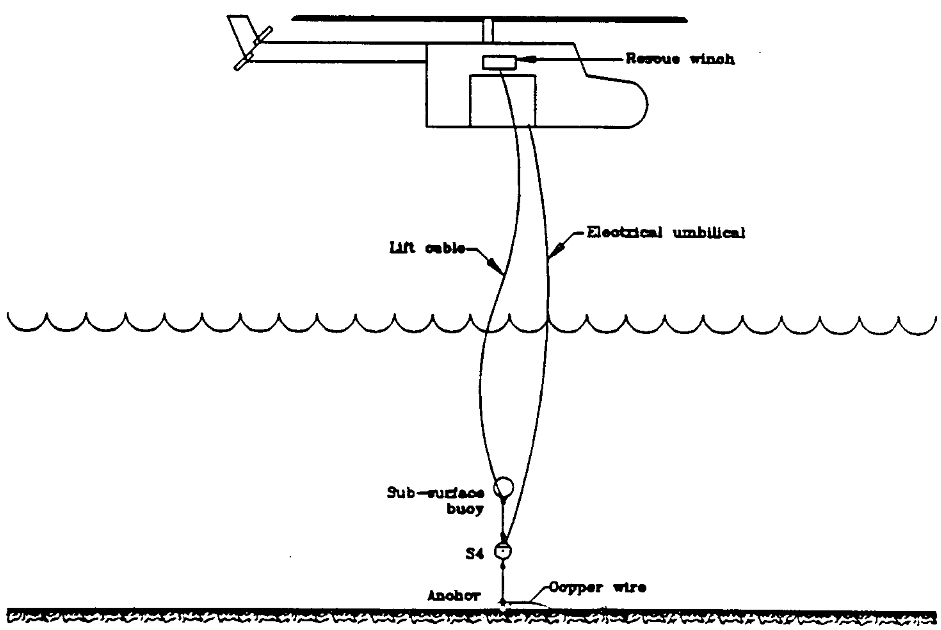

Figure 2. Meter assembly as it would appear in use at the sea floor.

measurement site, and the procedure is repeated. Figure 3 illustrates this data acquisition sequence. The helicopter pilot judges the distance between the site locations and keeps on line using the range markers. The survey crew only provides location instruction to the helicopter crew if they deviate greatly from survey or if the distance between site locations is not consistent with project requirements. While it is necessary to know the helicopters position at the time of sampling, for most applications it is not necessary to precisely position the helicopter at a designated location. This would require several minutes, significantly decreasing the number of sites that can be surveyed within the fuel time limit of the helicopter.

Site selections should consider bathymetry, previous dye studies, tracer studies, photos, model study results and any other available information concerning currents in the area. A grid pattern is helpful for aligning the helicopter during the study and also insures uniform coverage of sampling sites in the study area.

Selection of the sampling interval at each site is balancing two conflicting needs: rapid sampling to increase spatial resolution and measuring to obtain a sample of the site. One minute (approximately 6 wave periods) was selected to yield the best balance of the two needs. Allowing one minute for sampling and 4 minutes for helicopter maneuvering, a new site can be sampled approximately every 5 minutes, averaging 18 sites per 1.5 hour period.

<u>DATA PRESENTATION:</u> The S-4 meter records data continuously. The measurement time series can be correlated with location by comparison with the position time series from the survey instrument. The sampling period when the meter is on the seabed is easily identified from the depth output. Real time is used to correlate current data collection intervals with helicopter position. The one minute of data is averaged into a single resultant current vector for each site and the resultant vectors are displayed in mosaic form. The origin of the vector coincides with the data collection location and the length and head of the vector indicate relative speed and direction of the current at the time of sampling. In effect, the ACCESS creates a 1.5 hour time exposure snapshot of currents in a localized region. By conducting several 1.5 hour ACCESS studies, over a tidal cycle and under differing wave conditions, a comprehensive view of current pattern trends in a localized area can be achieved and at a fraction of the cost associated with a large scale current meter deployment effort.

<u>Example:</u> ACCESS was successfully tested at the Siuslaw River, Oregon at a cost of 35 thousand dollars for mobilization, demobilization and three days of current sampling. Its goal was to aid in documentation of current patterns around spur jetties constructed at the Siuslaw River mouth. Dauphin Rescue Helicopters supplied by the US Coast Guard were used for the Siuslaw River ACCESS Study. For the Siuslaw River, where the helipad is located very near the study site, helicopter pay load limits for personnel and equipment used in this study allowed the helicopter to be in the air between 1.5 and 1.75 hours before refueling. A fuel truck supplied with Jet "A" fuel mixed with "Prist" and anti-ice, anti-fungus agent was contracted for the study period to remove the need for the helicopter to return to its home base 60 miles from the study area for refueling.

Survey crew and total station were positioned on the jetties. Range poles on the beach and marker on the jetties formed the line of sight grid for helicopter

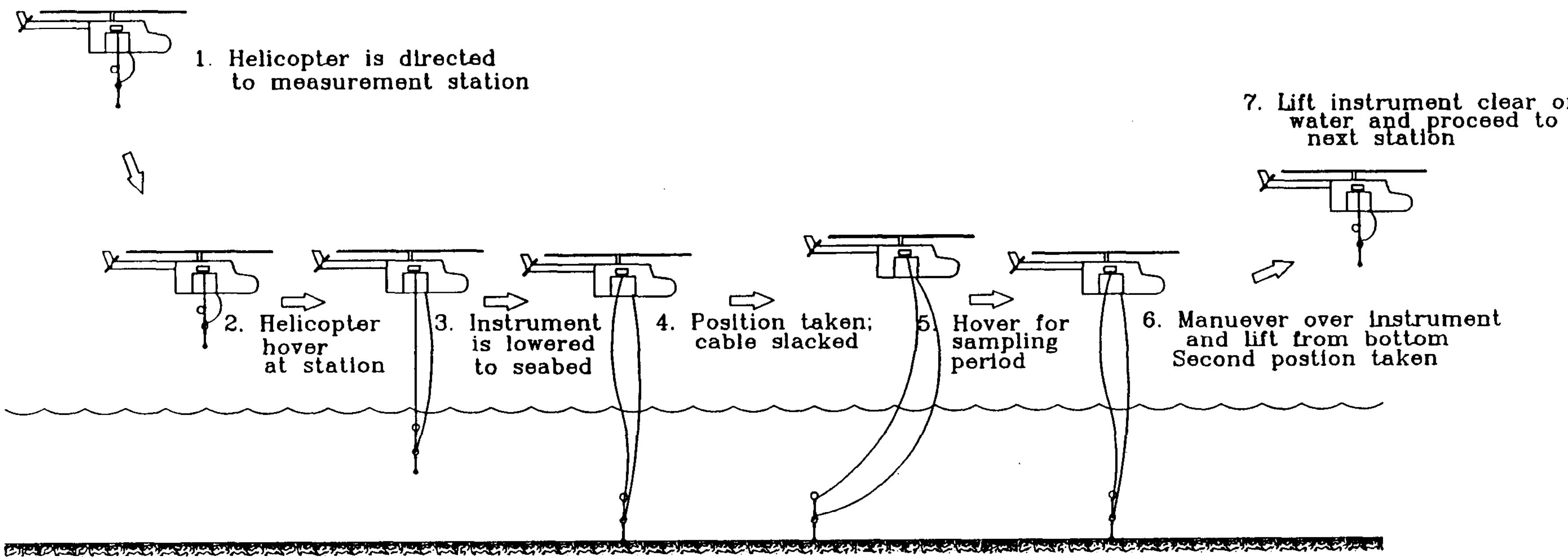

Figure 3. Sequence of helicopter positioning and data collection.

positioning. Figure 4 shows the jetty configuration and the proposed measurement sites locations and grid formation for the study at Siuslaw River. Figure 5 is an example mosaic presentation of currents vectors at 22 locations where measurements were made north of the Siuslaw jetties during a 1.5 hour sampling period. Wind patterns through out the study period were from due north at times exceeding 30 knots, current patterns reflect wind dominated current patterns for this 1.5 hour period.

<u>Summary:</u> ACCESS is and effective method for obtaining qualitative spatial resolution of bottom currents in hostile environments where boat operation is prohibitive and at a fraction of the cost of large scale current meter deployment efforts.

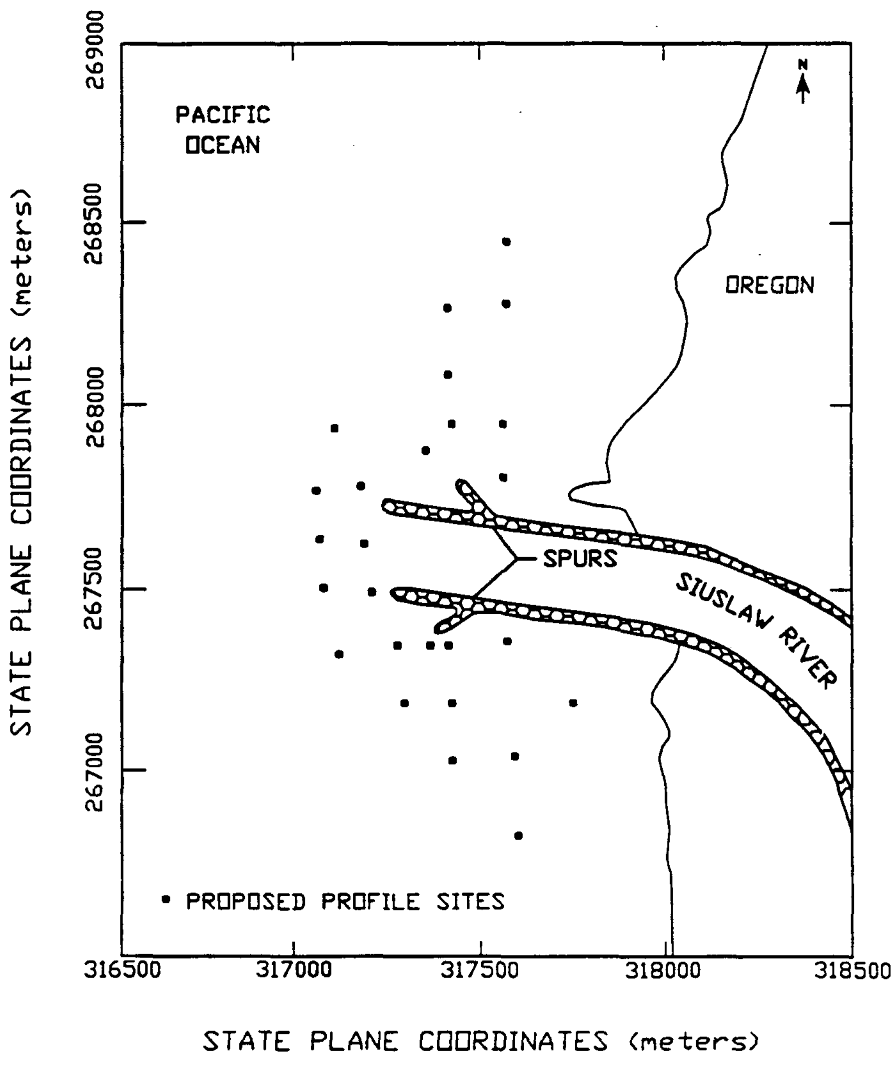

Figure 4. Proposed grid for Siuslaw River ACCESS Study.

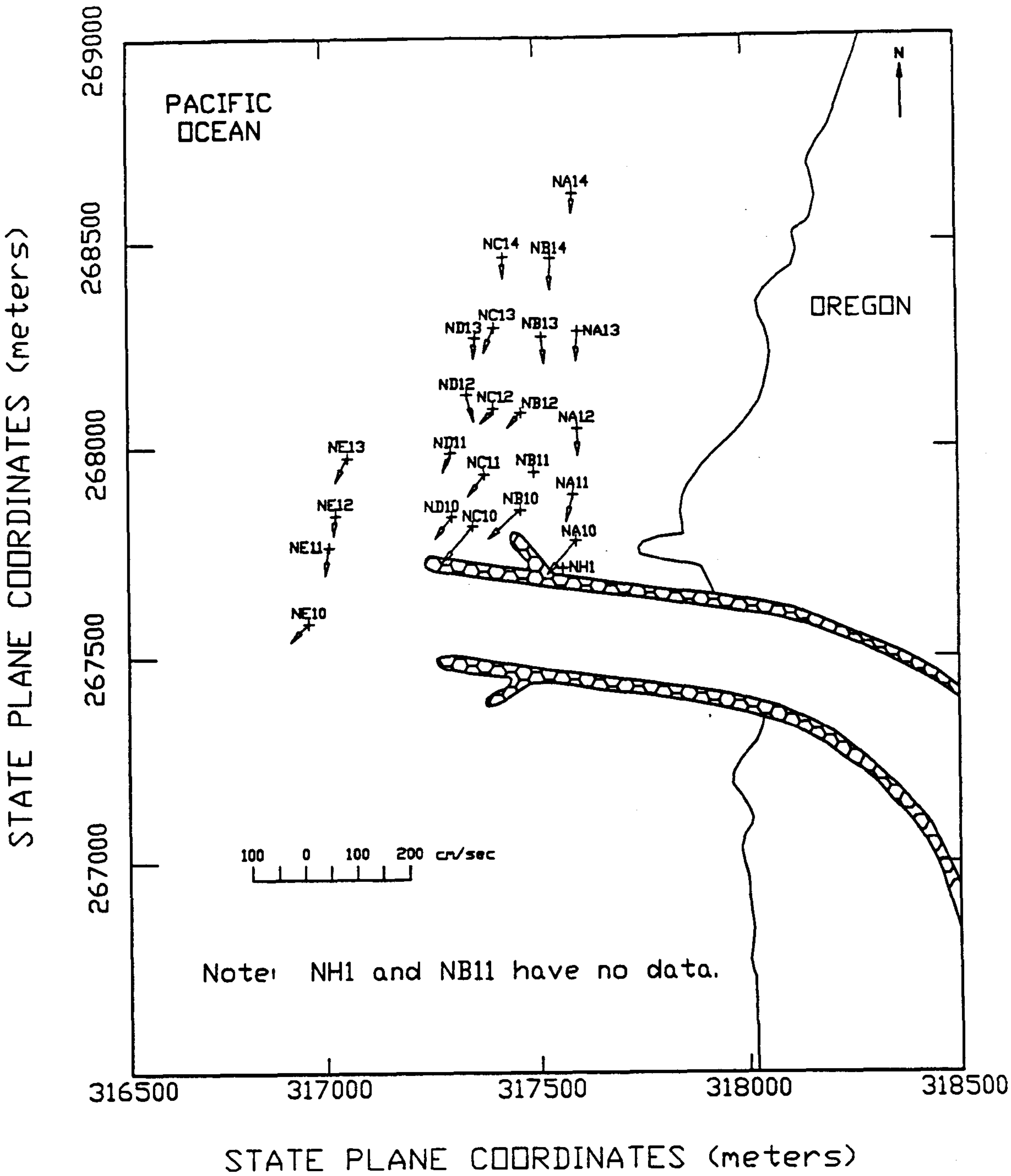

Figure 5. Actual sampling locations at Siuslaw River ACCESS Study.

ADDITION INFORMATION: For further information, contact Ms. Cheryl Burke Pollock, Coastal Structures and Evaluation Branch (WESCD-SE).

REFERENCES:

Burke, Cheryl E., 1990, "Helicopter Current Study at Siuslaw River, Florence, Oregon," The CERCular, Vol CERC-90-2, June 1990.